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A Performance Evaluation of the Intel 80286

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In the last issue of CAN we published a performance comparison of the Intel iAPX-432, Intel 8086, Motorola 68000, and DEC VAX-11/780. *We mentioned that Intel had announced a successor to the 8086, called the 80286. Intel is sampling parts now and will ship 8MHz and 10MHz versions next winter. In addition to new instructions that support 32-bit data, the 286 has a sophisticated protection mechanism reminiscent of MULTICS. The 286 also has a compatibility mode to run existing 8086 programs.

Tom Conroy, a Berkeley student, spent the summer working for Intel and measured the performance of the 286 on the same four programs used in the previous study. Conroy ran these programs on an actual 286 using a logic analyzer to count the number of clocks for each program. This breadboard has limited I/O thus the write statements were removed from program - this will have little effect on performance as there is almost no I/O. Since the 286 Pascal compiler was not available, the programs were run in 8086 compatibility mode.

The three critical performance tables have been reproduced from the original report with new lines at the bottom for the 286. The first two tables show the execution times and performance relative to a VAX-11/780 running VMS Pascal. Table 3 shows the performance of the microprocessors assuming an 8MHz clock.

This last table was the basis of one of the few critical comments that we have received on the previous paper:

> "You can't possibly get an adequate amount of no wait state memory in a microprocessor system. Inclusion of those times is misleading."

Sun Microsystems Inc. in Silicon Valley supplies an excellent counter-example. They are selling a 10MHz 68000 system without wait states for up to 1.75 megabytes - including memory management and parity on bytes.

The bottom performance line as measured by these four small programs is that the newest version of the 432 (8MHz with 4 wait states) is almost as fast as a 5MHz 8086, while the 80286 leads the 432 by almost an order of magnitude. Furthermore, this fast machine (in 8086 compatibility mode) outperforms a 16MHz 68000.

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*"A Performance Evaluation of the Intel iAPX 432," by P.M. Hansen, M.A. Linton, R.N. Mayo, M. Murphy, and D.A. Patterson in Computer Architecture News, Vol. 10, No. 4 (June 1982),pp. 17-26.

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Table 1. Execution times						
Machine	Language	word size	Time (milliseconds) search	sieve	puzzle	acker
VAX-11/780	C	32	1.4	250	9,400	4,600
	Pascal (UNIX)	32	1.6	220	11,900	7,800
	Pascal (VMX)	32	1.4	259	11,530	9,850
68000 (8MHz)	C	32	4.7	740	37,100	7,800
	Pascal	16	5.3	810	32,470	11,480
	Pascal	32	5.8	960	32,520	12,320
68000 (16MHz)	Pascal	16	1.3	196	9,180	2,750
	Pascal	32	1.5	246	9,200	3,080
8086 (5MHz)	Pascal	16	7.3	764	44,000	11,100
432/rel. 2(4MHz)	Ada	16	35	3200	350,000	260,000
432/rel. 3(8MHz)	Ada	16	4.4	978	45,700	47,800
80286 (8MHz)	Pascal	16	1.4	168	9,138	2,218
80286 (10MHz)	Pascal	16	1.1	135	7,311	1,774

Table 2. Performance Relative to VAX-11/780							
Machine	Language	word size	Ratio to VMX Pascal search	sieve	puzzle	acker	(>1=>faster) avg + sd
VAX-11/780	C	32	1.0	1.0	1.2	2.1	1.3 + .4
	Pascal (UNIX)	32	.9	1.2	1.0	1.3	1.1 + .2
	Pascal (VMS)	32	1.0	1.0	1.0	1.0	1.0 + .0
68000 (8MHz)	C	32	.3	.4	.3	1.3	.6 + .4
	Pascal	16	.27	.32	.36	.86	.5 + .2
	Pascal	32	.24	.27	.35	.80	.4 + .2
68000 (16MHz)	Pascal	16	1.1	1.3	1.3	3.6	1.8 +1.0
	Pascal	32	.95	1.0	1.3	3.2	1.6 + .9
8086 (5MHz)	Pascal	16	.2	.3	.3	.9	.4 + .3
432 (4MHz)	Ada	16	.04	.08	.03	.04	.05+ .02
432/rel. 3.(8MHz)	Ada	16	.32	.26	.25	.21	.26+ .04
80286 (8MHz)	Pascal	16	1.0	1.5	1.3	4.4	2.1 +1.4
80286 (10MHz)	Pascal	16	1.3	1.9	1.6	5.6	2.6 +1.7

Table 3. Performance at 8MHz						
Wait States	Machine	Language	Time (milliseconds) search	sieve	puzzle	acker
4	68000	Pascal	5.3	810	32,470	11,480
	432 (rel. 2)	Ada	17.5	1600	175,000	130,000
	432 (rel. 3)	Ada	4.4	978	45,700	47,800
0	8086	Pascal	4.6	448	27,500	6,938
	68000	Pascal	2.6	392	18,360	5,500
	80286	Pascal	1.4	168	9,138	2,218

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